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RESIDENTIAL FIRE PREVENTION

Alberta
MUNICIPAL AFFAIRS
Innovative Housing Grants Program

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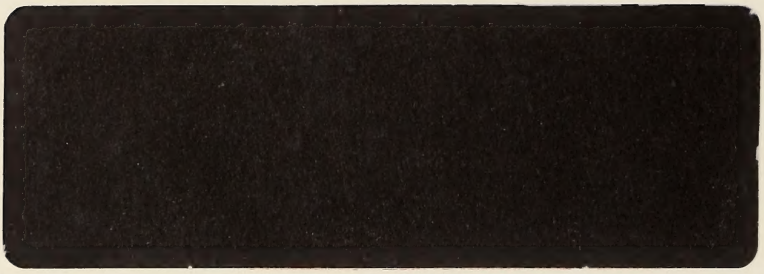

RESIDENTIAL FIRE PREVENTION

March 1988

Prepared by:

The Rockliff Group

The views and conclusions expressed and the recommendations made in this report are entirely those of the authors and should not be construed as expressing the opinions of Alberta Municipal Affairs.

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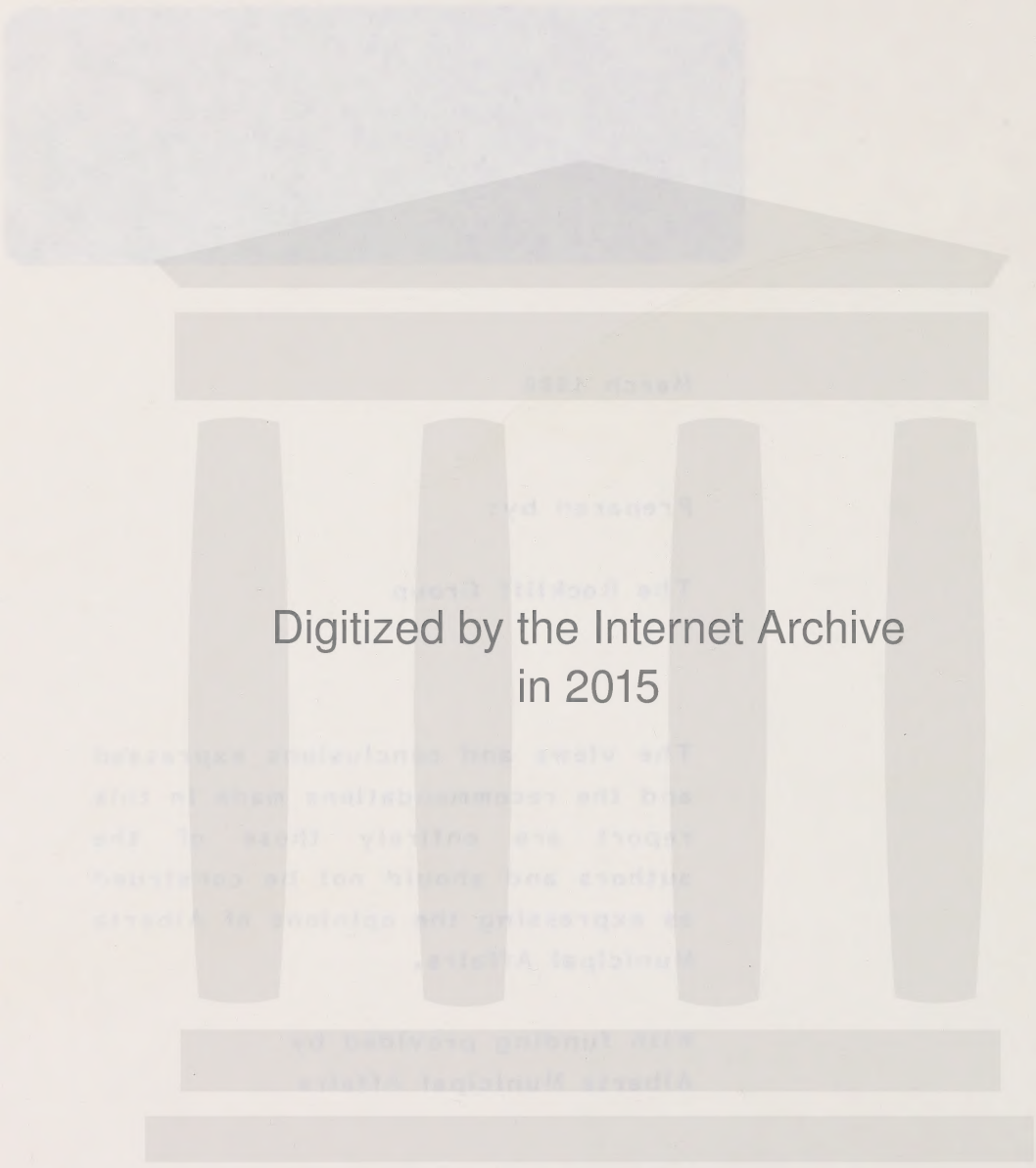

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FOREWORD

The project documented in this report received funding under the Innovative Housing Grants Program of Alberta Municipal Affairs. The Innovative Housing Grants Program is intended to encourage and assist housing research and development which will reduce housing costs, improve the quality and performance of dwelling units and subdivisions, or increase the long term viability and competitiveness of Alberta's housing industry.

The Program offers assistance to builders, developers, consulting firms, professionals, industry groups, building products manufacturers, municipal governments, educational institutions, non-profit groups and individuals. At this time, priority areas for investigation include building design, construction technology, energy conservation, site and subdivision design, site servicing technology, residential building product development or improvement and information technology.

As the type of project and level of resources vary from applicant to applicant, the resulting documents are also varied. Comments and suggestions on this report are welcome. Please send comments or requests for further information to:

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Dr. Betty Crown Clothing and Textile Department University of Alberta	Research/Testing, Sept. meeting
Mr Gerry Lawless Planning and Building Dept. City of Edmonton	Building Code/Plan Checking Sept. & Jan. meeting
Mr. Dick Massiah Building Inspection Alberta Department of Labour	Building Code Agencies, Sept. & Jan. meetings
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Mr. Don Pilling Edmonton Fire Department	Large community Fire Department, Jan. meeting
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Mr. Ian Reid Canada West Insurance	Insurance Industry, September meeting
Mr. Ken Saulit Devon Fire Dept.	Part-time Fire Chief, Sept. meeting
Mr. Fred Van Ry Kainai Industries	Mobile Home Manufacturer, Sept. meeting

Mr. Dick Veldhuis Grande Prairie Fire Dept.	Mid-size Community Fire Chief, Sept. meeting
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EXECUTIVE SUMMARY

- This document is the final report on a study of residential fire protection funded by the Departments of Labour and Municipal Affairs.

- This study examined a number of building technologies such as steel stud construction, fire retardant wood framing and sheathing, fire retardant paints and varnishes, etc. some of which are described in later sections of this document. However, in the course of our research it became evident that residential sprinkler systems and interconnected all-level smoke alarms/detection systems were more effective than other technologies in minimizing losses due to fires. Consequently, they have constituted a major focus of this study.

- We recommend that two fire protection technologies should be present in every home:

  - Interconnected all-level smoke alarms/detection system throughout the home.

  - Fire extinguishers.

- We believe that the current Alberta Building Code requirement for smoke alarms could be enhanced if it required the installation of a fully interconnected all-level smoke alarms/detection system in new housing. Consideration could also be given to developing a strategy that would encourage the same standards in existing housing.

- Residential sprinkler technology can provide highly effective and comprehensive fire protection in residences. As a result, sprinklers should be considered seriously as a requirement for new homes constructed in Alberta. This can be

achieved by planning/development ordinances, similar to those adopted by communities in the United States. We suggest that a long-term strategic direction towards the adoption of a provincial code for residential sprinklers be considered.

- In order to develop effective cost-benefit arguments for residential sprinklers more detailed study and analysis of the economic ramifications of sprinkler systems in U.S. communities should be investigated. We, therefore, recommend further study, which is discussed in detail in our conclusion section (6.0).

1.0 INTRODUCTION

This document describes the process, findings, analysis and conclusions arising from our investigation of provincial fire statistics and fire protection technologies in single family homes, duplexes and mobile homes used as residences.

This project was supported jointly by Alberta Labour and Alberta Municipal Affairs to review existing fire statistics and propose intervention techniques which would limit the spread of fires and reduce deaths, injuries and property loss. The project was conducted by The Rockliff Group, Planners and Architects in Association and Market Response Inc.

PROJECT OBJECTIVES

There were four objectives:

- Determine causes and location of fires in single and two-family dwellings and mobile homes.
- Identify possible ways to reduce or eliminate incidences of fire and/or fire damage.
- Assess the capability of various fire protection technologies in reducing the impact and severity of fires in existing residences.
- Recommend approaches for long-term fire protection measures in new residences.

RESEARCH METHODS

The process that was followed in this study is as follows.

Phase 1

In the first phase of the project, the consultants reviewed available literature on fire protection based on Canadian, American and United Kingdom sources, and analyzed Alberta Fire Statistics to determine the following:

- The nature, location and causes of fires in residential settings.
- Common elements of fires.

In addition, a telephone survey of key information sources throughout Canada and the United States was conducted.

Phase 2

In Phase 2 the opinion of outside experts on the findings of Phase 1 were sought through focus groups. The experts represented the following fields:

- Residential construction industry including manufacturers of mobile homes,
- Fire prevention and protection (small and large community representatives; and provincial government, Building Standards Branch),
- The insurance industry, and
- Manufacturers of fire prevention technologies (e.g. residential sprinklers, fire extinguishers, smoke detectors).

Phase 3

From the resolutions of the focus group held in Phase 2, the consultants obtained further information and data on the technologies selected for attention, and a second focus group was then conducted involving the same representatives with the addition of an individual from the City of Edmonton Water and Sanitation Department. An interim report was prepared for this phase which assessed residential sprinklers and smoke alarms/detectors. As well, other technologies to reduce fires and their impact were reviewed.

Phase 4

Assessments and reviews from previous phases were finalized and documented in the final Phase 4 report .

This report is based on the comments received from the focus group of experts and discusses each of the technologies investigated. The technologies are evaluated in terms of their ability to reduce fire losses, costs and practicality in dealing with potential fires in residences.

PROJECT ORGANIZATION

The report is organized as follows:

- Section 2.0 discusses the results from a statistical review of Alberta's Fire Statistics on the nature of fires in Alberta.
- Section 3.0 describes detailed information on various fire protection technologies.
- Section 4.0 specifically explores residential sprinkler systems.

- Section 5.0 discusses intervention strategies.

- Section 6.0 provides conclusions and recommendations arising from the project.

2.0 NATURE OF RESIDENTIAL FIRES IN ALBERTA

This section provides a summary of the major conclusions obtained from an analysis of Alberta's residential fire statistics. This summary highlights the major issues of residential fires, specifically their cause, source in the home, the potential damage they incur and fire protection measures.

2.1 SUMMARY OF ALBERTA FIRE STATISTICS

This section is organized as follows:

- Section 2.1.1 Causes of Fires in Homes
- Section 2.1.2 Comparison of Mobile and Conventional Homes
- Section 2.1.3 Origin of Fires
- Section 2.1.4 Fire and Smoke Spread/Damage
- Section 2.1.5 Fire Detection

2.1.1a)
Human failing is one of the most significant causes of fires in homes.

Over a quarter of the fires (28%) were caused by "human failing" (i.e., where the occupant was asleep, impaired by use of alcohol or drugs, etc.), 25% were caused by "misuse of source" (i.e., accidental misuse of materials); and 22% occurred because of mechanical/ electrical failure. The fourth most significant cause of fires is "misuse of materials ignited" (9%).

The categories "human failings", "misuse of source" and "misuse of materials ignited" total 62% of all fires.

The finding that twenty-two percent (22%) of fires are due to mechanical/ electrical failure suggests that substandard conditions of mechanical and electrical equipment in the home (e.g. heating equipment, wiring) may be a factor in residential fires. [1]

1 These statistics were obtained from a random sampling of residential fires, from Alberta Fire Statistics 1982 to 1984.

2.1.1.b)

The materials most likely to ignite first in a fire are the structural components, or finishing materials and flammable liquids such as paint/varnish.

In nearly 50% of the fire incidents from 1978 to 1984, flammable liquids and structural materials were the first materials to be ignited by the fire. Furniture, in contrast, contributed to the ignition of the fire in only 16% of fire cases.

2.1.2.a)

Alberta Fire Statistics indicate that fires in mobile home are more "serious" than fires that occur in single and two-family dwellings, and they are more likely to result in loss of life.

The proportion of fires that lead to death is higher in mobile homes (4.5%) than for single/two-family dwellings (1.3%). [2]

The average dollar loss in mobile home fires was significantly higher. In 1984 only 18% of mobile home fires had claims of less than $1,000.00, compared to 36% of one and two-family dwellings. Approximately half (52%) had claims of over $15,000.00, compared to 26% for single and two-family dwellings.

2.1.2.b)

Older mobile homes appear to have more functional or construction problems that contribute to the development of a fire situation, than do single and two-family dwellings.

Between 1982 and 1984, a higher percentage of mobile home fires were caused by mechanical/electrical failure than was the case in single and two-family dwellings.

A statistical study of mobile home fires prepared by Alberta Labour concluded that

2 The average is established by average proportion of deaths in mobile homes and single/two-family dwellings in the period 1978 to 1984.

the number of fires in mobile homes has continually dropped from 1966 - 1980; and that there has been "a reduction in the percentage of fires started by construction, design or installation deficiencies in newer model homes compared to those constructed in the early 1960's."[3]

There also has been a substantial drop in the fire death rate in mobile homes which were constructed after 1971. In mobile homes constructed after 1971, 6.5% of fires resulted in death compared to 8.6% for mobile homes constructed between 1966 and 1970. This finding was attributed to the 1969 CSA standard requiring mobile homes to use materials with improved flame spread ratings. As shown by this trend and the statistics in item 2.1.2.a) on page 6, fire safety in mobile homes has improved significantly.

2.1.3.a)

Fires originating in the kitchen accounted for 34% of all Alberta residential fires.[4]

The second most common area of fire origin was the living room area (14%) followed by the sleeping area (10%).

Fires originating in the kitchen were more predominant in single/two-family dwellings than in mobile homes (35% in single/two-family dwellings compared to 17% in mobile homes). Table #1 on the following page, outlines the proportion of fires that originate in different areas of mobile homes and single/two-storey dwellings.

---

3 A Statistical Study of Mobile Home Fires in Alberta, Alberta Labour, 1986.

4 This figure was obtained from an analysis of fire incidents in all three residential categories (mobile homes, single and two-family dwellings) 1982 and 1984. Therefore, this figure represents an average across both years.

Table #1:
Area of Fire Origin by Dwelling Type

Area of Origin	*Dwelling Type:* Mobile Home	Single/ Two-family
Living Room	10.2	15.0
Sleeping	12.1	11.4
Kitchen	17.0	35.0
Laundry	3.0	4.3
Unclassified Functional	5.7	3.6
Heating Equipment	14.4	7.0
Entrance	3.6	1.2
Crawl Space	9.1	.6
Exterior Wall	5.0	2.6
Structural Unclassified	7.0	3.0
	N = 835	N = 5,902

Note: Table # 1 was generated from the total sample of mobile home fires from 1978 to 1984 and a random sample of 75% of fires in single/two-family dwellings in the same time period. Only large item categories are included . Hence, figures will not add up to 100%.

If the items "crawl space", "exterior wall" and "structural unclassified" can all be grouped together as structural areas, then it would appear that the most significant areas of fire origin in mobile homes:

Structural	21%
Kitchen	17%
Heating Equipment	14.4%
Sleeping Area	12.1%

A higher proportion of fires that originate in the kitchen are extinguished by the occupant than is the case in the living room and bedroom (44% in the kitchen compared to 18% in the living room and 15% in the bedroom).[5]

5 1982 and 1984 fire statistics.

2.1.3.b)

For mobile homes, single and 2 family dwellings, fires that originate in the kitchen appear to have more serious consequences than those originating from other areas of the home .

Fires that originated in the kitchen had a higher person casualty rate (43%) than those that started in the sleeping or living room area (28% and 29% respectively). Also, kitchen fires were more likely to get out of control and extend to the entire house. Twelve percent (12%) of residential fires which started in the kitchen led to total burn out of the home compared to 3% of those which started in the bedroom and 8% of those that started in the living room.

2.1.3.c)

Kitchen fires are more likely to be caused by human error or accident than are fires originating anywhere else in the home.

Kitchen fires were most likely to be caused by human failing or accident (60%). In comparison, only 14% of fires originating from the bedroom or 13% of this from the living room were caused by human involvement.

2.1.3.d)

A quarter of fires in bedrooms (25.2%) were caused by children playing with ignitable materials and 24% by smokers.

Half of fires in the bedroom were caused by smokers or children playing with ignitable materials. The remaining 50% of fires were caused by an assortment of factors, the most significant of which were mechanical/electrical failure (13.4%, mostly electrical shortages) and human failing (9.1%).

2.1.3.e)

A significant proportion of fires originate in the basements.

Twenty percent (20%) of all fires originate in the basement of the home.[6] In Ontario, 28% of residential fires originated in the basement. This finding

6 1982 and 1984 fire statistics.

precipitated more investigation by the Ontario fire authorities, which resulted in the introduction of a regulation requiring all-level smoke alarm/detector systems. This requirement (i.e., for basement alarms in all dwellings) is not mandatory in Alberta's building code.

2.1.4.a)

One third of all residential fires tend to be small in terms of property loss.

One third of all residential fires result in property loss that is less than $1,000.00. An additional 22% of fires result in losses of $1,000.00 to $5,000.00 (1984 dollars).

2.1.4.b)

More damage seems to occur from smoke and heat than from charring and burning caused by the fire directly.

Although a fire may be contained to the object or area of origin in terms of the burning damage done, the heat and smoke it generates can extend far beyond the immediate area of the fire and do more damage than the fire itself. An analysis of the Alberta Fire Statistics (1984 residential fires) indicated that the fire itself extended to the entire building in only 18% of all fires. However, in the same sample, 37% of the homes experienced heat and smoke damage to the entire house.

2.1.4.c)

Corridors and stairwells are the prime avenue for smoke spread in a house. This fact about fires poses a significant hazard to the occupant in safely escaping the fire.

The primary avenues for escape, hallways and stairwells, experience the greatest potential inundation of smoke. In 65% of all fires, corridors and stairwells represented the main avenue by which the fire spread to the entire home.

2.1.5.a)

Smoke alarms/detectors appear to reduce the risk of fire spreading through the dwelling, presumably because they allow early detection.

In those instances where a fire alarm/detector was present and activated, the fire was more contained than in those situations where there were none. In 30% of the cases, where there was no coverage, the fire burned out the entire home compared to only 18% of cases where there was a fire alarm/detector present and activated.

2.1.5.b)

A significant proportion of residences which had experienced fires in 1984 were not adequately protected with smoke alarms/detectors.

Fifty-seven percent (57%) of homes had no fire detection coverage. Also, in those fire incidents where a smoke alarm/detector was present, 38% were not activated. The common reasons for inactivation:

- There was not sufficient smoke to cause the fire alarm to activate (37%) or the alarm was in an unsuitable location (4%).
- The power source (batteries or electricity) was not present or was inoperative (40%).

In the remaining cases the reasons were not known or clarified in the fire report.

2.2 CONCLUSIONS FROM FIRE STATISTICS

The fire statistics indicate that there are common causes of home fires and areas in the home where fires are more likely to occur. By understanding which areas of the home tend to be the greatest fire risk and what situations are likely to arise in the event of a fire, the consumer or home-builder can select ways and means of better protecting against them.

Six facts about residential fires in Alberta should be considered in determining fire protection strategies and technologies:

FACT #1:

Most fires (65%) are caused by direct human action or human failing, i.e. somehow action or lack of action by the occupant caused the fire.

FACT #2:

Twenty-two percent of fires are caused by a failing in the mechanical/electrical systems of the home.

FACT #3:

Thirty-four percent of home fires originate in the cooking area of the kitchen. Usually these fires occur when the occupant is present and are more likely to be extinguished by the occupant than fires that originate elsewhere in the home. However, if kitchen fires get out of hand they can lead to the greatest damage.

FACT #4:

Twenty percent of fires originate in the basement.

FACT #5:

The incidence of fires originating in the bedroom is comparatively low (14%). Bedroom fires tend to be caused by smokers and children playing with ignitable materials.

FACT #6:

More damage is caused by smoke than by the fire itself. Smoke migrates to various parts of the home through corridors and stairwells, and openings in the wall. This can present a serious difficulty for occupants by blocking their escape path.

3.0 FIRE PROTECTION TECHNOLOGIES FOR THE HOME

There are several possible technologies that a homeowner might consider in better protecting his home in the event of a fire. These include:

1.	Smoke alarms/detectors (Section 3.1)
2.	Fire extinguishers (Section 3.2)
3.	Dedicated appliance extinguishers (Section 3.2)
4.	Residential water hoses (Section 3.2)
5.	Fire retardant building/finishing materials, e.g. framing and sheathing and paint, non-combustible insulation (Section 3.3)
6.	Steel stud construction (Section 3.3)
7.	Containment of fire through design (Section 3.4)
8.	Fire retardant furnishings (Section 3.5)
9.	Maintenance (Section 3.6)
10.	Residential sprinklers (discussed in a separate section 4.0)

This section of the report discusses each of these technologies (excluding residential sprinklers) and the benefits and limitations of each in reducing the risk of fire and/or damage caused by fire in the home. Wherever appropriate, details, costs and potential application in Alberta are provided.

The last technology, "residential sprinklers", is discussed in a separate section (#4). We found in our investigation that of all the technologies investigated "residential sprinklers" afforded the most comprehensive protection for the homeowner and could, if installed, render some of the other technologies redundant. In addition, practical experience with residential sprinklers in other communities suggests that their universal use in both residential and commercial installations throughout a district, could offer significant opportunities for municipalities to reduce overall costs for firefighting.

The information that is presented on the available technologies was derived from a compendium of various sources, primarily:

- Experts in fire prevention/fire fighting
- Reports and studies on the technologies
- Information from manufacturers

3.1 SMOKE ALARMS/DETECTORS

Increasing the effectiveness of smoke alarms/detectors can have a significant impact on reducing the extent of the fire and in increasing the opportunity for the occupants to escape.

BACKGROUND

The fire statistics indicate that in those situations where a smoke alarm/detector was present, the extent of fire damage to the house was substantially reduced. This finding was also supported by experiences and studies conducted in other countries.

Analysis of Alberta Fire Statistics and other studies indicate that a significant proportion of the battery powered detectors used in housing stock constructed before 1977 are not maintained properly and are ineffective at the time of a fire.

The Alberta Building Code since 1977 has required that a smoke alarm be installed in all new homes.

One of the key findings of this study is that the minimum requirement for smoke alarms/detectors in the code could be improved to provide better protection for Alberta residents. By placing alarms in those areas of the home where fire is likely to start and in a manner where detection and response time by the occupant can be improved, the potential risk of a severe home fire can be reduced.

There are several avenues for improving the effectiveness of smoke alarms/detectors:

... Locate the fire alarms/detectors in potential fire areas of the home (e.g. in the basement, bedrooms where children play or a smoker sleeps) to increase the early detection of a fire.

... Install an electrical alarm system that is hard-wired to the home electrical system, rather than battery operated, to ensure that the alarm will always be operative (except possibly for situations where there is an electrical fire or power failure).

... Install an interconnected smoke alarm/detector system in the bedroom to ensure that occupants have a greater chance of hearing the alarm as early as possible.

Studies indicate that the decibel range and the sleeping condition of the occupant can have a significant impact on occupants' response to the alarm. However, the presence of air conditioners operating in the room, closed doors and distance of the alarm from the sleeping occupant lowered its effectiveness in waking the occupant[7].

Another study conducted by Michael J. Kahn[8] illustrates more specifically that "a smoke alarm warning must reach relevant pillow sites in excess of some unknown value which is greater than a 10 dB signal to noise ratio. Should future research identify this value more specifically, fire safety standards could be improved. The triggering of a remotely located alarm will not necessarily present a cue sufficient to awaken a person. Thus, it is essential to bring about potent fire cues to the sleeping quarters. Methods of tying remote smoke detectors into alarms proximal to the bed should be sought."[9]

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7 Dr. E. Harris Nobe of the University of Massachusetts at Amherst conducted this study for the NBS Centre for Fire Research.

8 Op cit, Michael J. Kahn, p. 20.

9 Ibid, p. 26.

Smoke alarms/detectors do not have any inherent capability to prevent or ameliorate fire situations. Their key benefit is to provide the occupant with an opportunity to escape and to notify the fire department.

PLACEMENT OF SMOKE ALARMS/DETECTORS

In addition to the requirements in the Alberta Building Code, our review of literature and discussion with the focus group of experts on smoke alarms/detectors suggests the following optimal locations:

- A better room by room location for smoke alarms/detectors related to the potential sources of a fire, including the basement and each level of the home[10].

- An electrically interconnected smoke alarm/detector system throughout the home. An interconnected heat detector is recommended for use in kitchens[11].

- The placement of a smoke alarm/detector device in the bedrooms of a residence.

  Some studies have indicated that sleeping occupants may not necessarily hear an alarm located outside their bedroom, particularly if the door is closed. Therefore, an alarm device in the bedroom could increase the chances of detection and improve the escape time for the occupant.

Although the focus group agreed that the standards for smoke alarms/detectors in

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10 Participants in the focus group suggested that heat detectors would be more appropriate in the kitchen than smoke detectors to reduce the risk of smoke alarms being set off inadvertently.

11 Inexpensive residential heat detectors which are capable of being interconnected into the smoke alarm detector devices are not readily available at this time.

the Alberta Building Code should be improved, there was some question on the political feasibility of making the code retroactive to existing homes. It was argued that the problems inherent in retroactive legislation should be examined further; and that an educational program, possibly connected with a government incentive scheme similar to that for insulation, should be investigated as a possible alternative strategy to encourage the public to install smoke alarms/detectors in a prescribed manner.

PRODUCT INFORMATION

There are two general types of residential detectors: Photoelectronic and Ionization.

Ionization Detectors: A chamber containing two electrically charged plates and an equal number of positive and negative charged ions creates a minute ionization current. When products of combustion enter the chamber, the balance of the ionization current is interrupted causing an alarm.

The Ionization type detector is better in detecting fast flaming fires which are characterized by smaller size combustion particles.

Photoelectronic Detectors: There are two basic types of Photoelectronic detectors -- one is the light obstruction detector. The principle in this type is a light source directed at a photo-sensitive device. When smoke particles interrupt the light beam, the receiver initiates an alarm signal.

The second and more common type operates on the light scattering effect. A source of light is beamed into an area not normally seen by the photo-sensitive device. When smoke particles enter this area, they reflect light onto the photo-sensitive device, thus initiating an alarm.

The photoelectronic type detectors are better in detecting slow smouldering fires, which are characterized by larger combustion particles.

Combination Photo/Ion Detectors: Detectors are now available which combine the Ionization and Photoelectronic detection systems. The combination of these sensing technologies provides effective warning of both types of fires. These types of detectors are less prone to nuisance alarms because neither function has to be calibrated to its peak sensitivity.

Operation: Both types of detectors are available in either battery or A.C. power source. Battery powered units are primarily for retrofit applications. In new construction the direct wired A.C. units are required by code.

Some models allow for the interconnection of devices (up to 12 devices for the directly wired A.C. units) (some battery powered units do not allow for interconnection). As well as the ability to interconnect devices, it is also possible to connect some units to a control panel or other device such as an automatic dialer.

Heat Detector: Another type of alarm is the heat detector. It is activated when a certain temperature is exceeded. Its weakness is that it must be close to a fire to set off the alarm. It can be especially useful in environments where a smoke detector could be easily fooled (such as a kitchen where grease particles may cause false alarms in a smoke alarm system). However, Consumer Report suggests that a heat sensor is "not a substitute for a smoke detector". A heat detector is capable of totally ignoring a smouldering fire that generates lethal amounts of smoke, carbon monoxide and other toxic gases.

PRODUCT AVAILABILITY

There are four major manufacturers' products available in Alberta: **BRK, Dycon and Nortron,** and **First Alert.**

Other manufacturers make detectors for institutional application, including Edwards, Gamewell and Simplex.

COSTS

The cost for installation of a fully integrated smoke alarm/detector system, based on six alarms[12] as proposed in this document, for a new house with three bedrooms and two storeys would be approximately $300.00. This cost includes installation and wiring for an interconnected system. For a retrofit installation, the cost of installation of an interconnected system can be up to 25% more than for a new home.

3.2 FIRE EXTINGUISHERS

3.2.1 Hand Held Fire Extinguishers

Fire extinguishers can provide a positive and direct opportunity for the home owner to protect him/herself in the event of a fire, and can be highly effective in fighting residential fires.

BACKGROUND

Fire extinguishers can be highly useful in combating one of the potentially most lethal fires that occur in residential settings, i.e., kitchen fires. Alberta Fire Statistics indicate that approximately 34% of residential fires originate in the kitchen and a large proportion of these occur around the use of the stove.

Other fire sites such as basement furnace areas (20% occurrence) and bedrooms (14% occurrence) would also be well served by the installation of well located extinguishers.

Experts in the focus group argued that, in the absence of residential sprinkler systems, properly located fire extinguishers are essential in every home.

12 Consideration might be given to a heat detector in the kitchen instead of a smoke alarm.

Extinguishers can be highly effective at the initial stages of a fire. However, the occupant should be aware of how to operate the extinguisher. Inappropriate use of the incorrect type of extinguisher (designated A, B and C) could actually help spread the fire.

PRODUCT INFORMATION

Household extinguishers, usually containing dry chemical, water or Halon gas, are designed to put out small fires not big ones. Some have more ability to put out fires than others. Note should be taken of the number on the unit's ULC certification - the higher the number, the larger the fire it can put out.

Lightweight fire extinguishers are available for home use but most popular are the multi-purpose or ABC models. Extinguishers are classified by the letters A, B and C[13] according to their ability to fight different types of fires:

*Class **A** Fires: Wood, paper, textiles, plastics, rubber and other solids*

To combat an "A" fire you need to smother it and cool the burning material; otherwise the embers can rekindle as they gain oxygen and heat. That's why water is generally used to fight class A fires.

*Class **B** Fires: Inflammable liquids like gasoline, paint solvent, grease and oils*

Class B fires can be explosive and must be totally smothered. The person operating the extinguisher must avoid spattering the burning liquid or dousing it with water, which will cause the fire to spread.

*Class **C** Fires: Live electrical wiring and appliances*

Never attempt to fight a class C fire with water because water conducts electricity.

13 There is a fourth class of fires, "D" Class, which are limited to the type of fire found in industrial or laboratory settings.

A "C" rating carries no numerical prefix. It simply means that the extinguishing material is non-conductive and therefore safe for electrical fires.

Class A, B and C fires can be fought with the following Extinguisher Models: Flag ABC-025, Flag ABC-050, Chubb on Guard ABC 5P-4, Chubb on Guard ABC 2l/2P-4 and Sure-Way all manufactured in Canada as well as General C-TCP-2 l/2J and General C-TCP-5J manufactured outside Canada.

They range in price from $25 to $50 (Canadian 1987) and their refill cost is usually less than $10.00.

Class B and C fires can be fought with the following extinguishers: General C-GH-3J, General C-CP-5J, General KCP-2 l/2J, Red Cap Super 2, Super Pro M2l0R, not manufactured in Canada, or Flag PKD-050 which is manufactured in Canada.

These are available in prices between $20.00 and $120.00 (1987 prices).

This is not an exhaustive list and other extinguishers are available. The important consideration is to ensure that the extinguisher carry a U.L.C. certification.

Appendix "D" provides some tips on how to use fire extinguishers.

3.2.2 Dedicated Appliance Extinguishers

Other types of extinguisher which can reduce the instances or extent of kitchen fires are appliance-attached suppression mechanisms. These are not readily available and can be very expensive. Commercial range top fire suppression units are costly, cumbersome and generally unsuitable for residential use.

However, individual cylinders complete with their own sprinkler heads are

available which can be mounted onto kitchen ranges. One such product is the Firefox Automatic Kitchen Range Fire Extinguisher which provides up to 7 square feet of coverage using a chemical compound. This product is worth considering given that 34% of home fires start in the kitchen. This product should be available in Canada during 1988 and will market at between $400 or $500 Canadian and will be available from Tara Manufacturing Ltd. P.O. Box 265 McCadam New Brunswick. No other products of this type were available from the literature and product search.

Due to the newness of this product, very little information is available on its effectiveness.

Its potential advantage over handheld fire extinguishers; however, might be that it will operate without the occupants being present; and provide a homeowner with similar protection as a residential sprinkler in a small area of the home.

3.2.3 RESIDENTIAL WATER HOSES

DESCRIPTION

There is considerable interest in the possibility of retrofitting a garden hose into a closet of the home, as protection against fire emergencies. The suggestion was that a "garden hose" in a conveniently plumbed area of the house might be useful with Class A fires (wood, paper,textiles, plastic, rubber and other solids) but not adequate to fight B and C class fires.

LIMITATIONS

Although potentially cost effective, this extinguisher system was not generally supported by the experts who attended the focus group sessions. There were several limitations:

- The hose would not necessarily be located where the fire was likely occur. Therefore, it was only effective for that area of the home where it was placed.
- Garden hoses may not be durable enough to provide sustained protection in a fire.
- Unless the homeowner knows how to handle a hose to put out a fire, it could be potentially dangerous, both in delaying notification of the fire station and delaying his safe exit from the fire scene.

A solution that might satisfy the durability issue, is a device manufactured by Fire Prevention Plus Inc., called ***Fire Aid***. The manufacturers claim that it is the "do it yourself" fire station for the home containing three compartments to separate 1) a small 2 1/2 lb. A.B.C dry powder or Halon Extinguisher for small grease or electrical fires, 2) a special flexible fire hose 50 - 75 feet or 100 feet long, and 3) a special fire valve and micro-switch assembly which inhibits premature activation of the water. The whole assembly is housed in a heavy duty steel cabinet which is framed into the stud wall and is concealed by a mirror, photograph or painting. This is the only product of this type that the consultants found available. It can be obtained for approximately $399.00 (Canadian 1987) from Tara Manufacturing Ltd., P.O. Box 265, McCadam, N.B.

3.3 FIRE RETARDANT BUILDING AND FINISHING MATERIALS

BACKGROUND

In approximately 50% of fire cases, the fire is spread by structural components and ignition of flammable liquids (e.g. paints and varnishes).

This finding from the Alberta Fire Statistics suggests that technologies such as fire retardant framing and sheathing, fire retardant paint and non-combustible insulation could potentially reduce the spread of fires.

Although these materials could not control a fire situation, they could potentially slow the rate at which a fire is likely to develop and thereby allow greater response time for the fire department.

Several writers have argued that the value of these materials must be considered in terms of the reduced risk they offer in fire situations, the contexts in which they are used and other fire detection and protection interventions present in the home.

Each of these materials is discussed individually in this section.

LIMITATIONS

The three materials discussed in this section are not easily applied in retrofit situations. The cost of repainting the home with fire retardant paints, etc. may be prohibitive for the benefits gained. Extensive renovations or new construction projects are less problematic.

There has been some question regarding the safety of some of the materials. Therefore, the consumer should inquire about any health or safety hazards that might be associated with some of the materials.

3.3.1 Fire Retardant Wood Framing and Sheathing

Fire retardant wood framing and sheathing is made by coating the material with soluble inorganic chemicals such as ammonium sulphate, ammonium phosphate and to some degree zinc chloride.

Because some of the chemicals used are hygroscopic in nature (i.e., absorb water), the woods can take on moisture and create corrosion of common metals used in framing, such as nails and truss plates.

The manufacturers are changing the composition of some of the fire retardant chemicals by using mixtures of both organic and inorganic salts; as a result manufacturers claim that hygroscopic problems are resolved. Consumers who are considering this technology should discuss these issues with the manufacturer.

This technology can add approximately 3% to the capital cost of a home.

There is only one company in western Canada that treats lumber to be fire retardant, i.e., B.C. Cleanwood, Surrey, B.C. The cost is $220.00-$250.00 to treat 1,000 board feet (1"x1'x1') plus handling, in addition to the cost of the lumber itself.

3.3.2 Fire Retardant Paints

Fire retardant paints may be applied to wood or other building materials to reduce combustibility and surface flame spread. Manufacturers claim that these paints can provide additional time (l0 - 20 minutes) for safe building evacuation and are commonly used in stairwells/corridors for safe exiting in a fire situation. Typically, they have been used in institutional facilities such as hospitals, nursing homes and schools and not in residential construction.

Intumescent paint has a lower flame spread rating[14] than overcoat or standard paint. The intumescent coating expands when subjected to the high heat of a fire and prevents contact of the flame with substrate.

Costs for fire retardant paint range from 25 to 95% more than for standard paint finish. The cost varies on the sheen of the paint. The paint falling in the higher range (95%) is for a solvent based latex paint with flat sheen. The consumer should

14 Flame spread rating is a classification used in the Alberta Building Code which indicates the "spread-of-flame on the surface of a material or an assembly of materials as determined in a standard fire test". In the fire test, materials are classified according to their relative surface burning characteristics, when compared with a known "combustible" such as red oak and a known "non-combustible" such as asbestos-cement board.

be aware that the finish of these types of paints is not as durable as standard paints; and that when subjected to touching, they lose their effectiveness.

3.3.3 Non-Combustible Insulation Materials

There are both combustible (e.g. polyurethane and related materials) and non-combustible insulation materials available on the market. Light weight materials such as fibres and foams will ignite more easily than similar materials in solid form and tend to contribute to rapid fire growth. The degree of risk depends on the degree of exposure to heat[15]. Board materials used as linings can also contribute to fire spread across their surfaces; and organic materials will produce toxic combustion products and their burning often is accompanied by thick smoke[16].

In the publication, Contribution of Insulation in Cavity Walls to Propagation of Fire Life, by the National Research Council, tests were carried out to examine the contribution of insulation material in cavity walls in the propagation of fire. Materials with various flame spread ratings were tested under conditions similar to actual in-home situations.

It was found that an insulating material used in a vertical position between two layers of non-combustible material with an intervening air space was not likely to contribute to fire propagation if it had a flame spread rating of 25 or less.

Although this only approximates the conditions found in most residential construction in Alberta, it does indicate that the most commonly used insulation materials made of fibreglass products which have low flame spread ratings, would

15 "Polyurethane Foam Insulation: Fire Risks and Safety", the Upjohn Chemical Division Technical Bulletin 107, Torrance, CA: 1981.

16 Building Research Establishment, "The Fire Hazard from Insulating Materials", Fire Engineer's Journal, March 1980.
Op cit, The UpJohn Chemical Division Technical Bulletin 107.

not contribute significantly to fire propagation in wall or roof construction.

Fiberglass pink insulation, for example, has a flame spread rate of 15, and Vapour Seal Insulation in fiberglass products has a higher rating of 20. A product such as mineral wool is not commonly used in residential construction nor is foamed silicon, the latter because of high costs. Alternate insulation materials can be used in residential construction such as polystyrene products which do have higher flame spread ratings. There is also a trend towards cellulose fiber impregnated with fire retardant chemicals being used in residential roof insulation. This product also has a flame spread rating of 15.

3.3.4 Steel Stud Construction

BACKGROUND

Steel stud construction is not commonly used for residential development and there is little available literature to indicate possible benefits of this technology in residential settings.

FIRE PROTECTION QUALITIES

The value of a wall in providing protection against fire is based on the following criteria:

1) the exterior wall's ability to contain a fire within, thereby preventing fire spread over exterior surfaces to upper floors or roof;

2) its ability to prevent ignition of the building itself by fires (outside the building);

3) its ability to maintain structural integrity of door openings and other escape routes for building occupants; and

4) its ability to contain a fire within, preventing spread to nearby combustible materials and buildings.

The authors came across very little material at this time to suggest that steel stud construction would in fact function in a more cost effective and superior mode given the above considerations.

The requirements for ensuring protection against fire are similar in all four cases.

COST

One of the reasons this technology has not been extensively studied by experts in the field of fire prevention is its cost. This form of construction would not be cost effective in residential construction compared to standard wood framing. Generally it is 2 1/2 to 5 cents per square foot of wall surface more expensive than wood framing. Also a decision on the main spanning elements in the house (trusses or joists) would be affected by the use of steel stud or wood stud walling techniques. The use of steel stud construction in residences is uncommon in Canada and therefore it is difficult to obtain costs estimates.

3.4 CONTAINMENT OF FIRES THROUGH DESIGN

BACKGROUND

Building geometry is highly related to fire spread. Also, the literature review revealed that more people were killed or affected by smoke from a fire than by the actual fire itself.

DESIGN CONSIDERATIONS FOR FIRE PROTECTION

Seven factors related to the design of the house were identified in the literature as relevant areas of attention.

- "Most fatalities on the second floor were found in bedrooms with the door to the room open. They had been overcome within two to five minutes of fire discovery by smoke and hot gases rising up the staircase. Only three (all young children) were overcome in their beds; the others got up and moved around before being overcome[17]."

- The same study noted that occupants of a bungalow or ground floor of a house who were remote from the room of fire origin were in little danger of death or injury. Fewer casualties occur in single level homes. Occupants were better able to escape through an external doorway in a single family dwelling than occupants of two storey buildings.

- In all types of housing design it should be noted that fire resistant doors with simple automatic closing devices can help to contain a fire in a compartment.

- Large open space designs can contribute to a fire spread because the fire cannot be compartmentalized. This suggests that smaller rooms with closing doors can compartmentalize a fire more effectively, allowing occupants a longer time for escape.

- The degree of ventilation may contribute to a fire. However, ventilation and fire load[18] are random variables and cannot be controlled.

- Inadequate fire barriers at the top of separating walls between duplexes are a major contributing factor to fire spread[19].

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17 Silcock, et al.

18 Fire load is based on the variable combustible elements in the home and their combined action in the event of a fire.

19 Atkinson, "Putting a Stop to Fire Spread".

- Exposed wall and ceiling surfaces and the thermal characteristics of a room influences the conservation of heat and therefore fire growth.

CONCLUSIONS

It seems that although building design/configuration plays a significant role in fire scenarios, it would be very difficult to draft legislation requiring builders to conform to these considerations. This solution, therefore, is not readily available to the average homeowner. However, the individual consumer who is planning to design his own home, may be able to introduce some design features which will allow better containment and control of fires.

3.5 FIRE RETARDANT FURNISHINGS

BACKGROUND

Fire resistant furniture materials were examined in this study. Although the statistics suggest that only 16% of Alberta residential fires involved furniture as materials first ignited, the potential hazards of modern furniture should not be downplayed. Although furniture materials cannot be blamed extensively for igniting a fire, they do present a hazard in almost any fire situation when it escalates to the point of involving furniture in the home.

There has been growing concern over the years about the dangers inherent in certain home furniture materials and their role in accelerating or intensifying a fire situation. Many scientists and researchers argue that the fire atmosphere has become more poisonous as a result of the widespread use of synthetic polymers as materials of construction, furnishing and decoration[20].

20 Fire Research Station and Building Regulations, Professional Division, "Polymeric Materials In Fires, BRE Current Paper, 1974, No. 91.

Most modern furniture contains thermosplastics which can burn rapidly when ignited and which give off toxic gases[21]. These toxic gases (primarily carbon monoxide, hydrogen cyanide and nitrogen oxides) tend to rise and escape throughout the home.

In one investigation researchers found that due to the hazardous nature of the fire involving synthetic furniture materials, occupants on the second floor of a house (immediately above the fire) had very little time to escape. In those instances where the door from the room below was open and modern furniture was involved, the occupants in the bedrooms above were in the most danger[22].

Fire tests indicate that for small domestic fires, with relatively low temperatures being reached in comparison to industrial fires, the cyanide risk is not significant in relation to the amount of carbon monoxide released[23].

These incidents confirm the increasing number of reports from firefighters that modern fires are more noxious, hotter and of a shorter duration (i.e., burn faster)[24].

FIRE RETARDANT MATERIALS

Effectiveness of this solution depends upon the availability of furniture products made with fire retardant materials. Currently consumers are not highly conscious nor significantly predisposed to fire retardant furniture materials; nor are these products readily available in a wide choice of fabrics.

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21 "Burning of Furniture and Furnishing", by Dr. W.D. Woolley, Fire Engineer's Journal, December 1979, p. 27.

22 See further discussion in Phase 1 literature review report.

23 Woolley and Palmer, "Plastics in Fires and Toxic Hazards", in Building Research Establishment News, Vol. 37, Autumn, 1976, p. 12.

24 W. Harland, p. 30.

In order that this choice becomes a viable one for consumers, two levels of intervention are required:

- An awareness program to consumers that will sensitize them to furniture products made with fire retardant materials. Studies by Betty Crown from the University of Alberta indicate that fire retardant furniture material is not a significant consumer demand. When faced with a variety of attributes regarding furniture, fire retardant materials had a low priority in consumer preferences.

- Development of standards for furniture manufacturing at the federal level. Currently, the government has initiated discussions with furniture manufacturers to encourage them to voluntarily adopt standards that would benefit public safety.

Even when fully implemented, attempts by the furniture manufacturing industry to regulate itself towards safer furnishings, the benefits that might be expected from this technology can only be anticipated in the long-term. Experts estimate an approximate 15 year turnaround from the time manufacturers establish appropriate standards before most homes are safely furnished, due to the fact that most consumers keep furniture for a significant period of time.

3.6 MAINTENANCE

The analysis of Alberta Fire Statistics indicates that a significant proportion of fires are related to mechanical/electrical failure in the home.

One area where homeowners could reduce their risk of fire is to improve the state of mechanical equipment (e.g. the furnace) and electrical wiring, if these are substandard. This finding was further corroborated by an insurance representative in one of our focus group sessions. He stated that homes that are in disrepair or are neglected tend to be the most prone to fire. The conclusion was made that people who take care of their homes are less prone to have fires.

Owners who wish to undertake a program of fire prevention are advised to engage mechanical and electrical contractors to review their existing systems and make recommendations for upgrading and implementing a homeowner's maintenance program.

4.0 RESIDENTIAL SPRINKLERS

4.1 RATIONALE FOR FOCUS ON RESIDENTIAL SPRINKLERS

Residential sprinklers are discussed in a separate section, for the following reasons:

- Of the technologies examined, sprinklers are judged to provide the homeowner with the most comprehensive fire protection and suppression capability, whether he is present in the home or not. Sprinklers can ameliorate nearly all possible fire scenarios in residential settings. Unlike specific technologies such as fire retardant paint, use of fire retardant materials in furniture, etc. they can deal with a variety of fire origins. Unlike alarms, they have a suppression capability[25]; and unlike handheld extinguishers, they are designed to work if no one is home.

- Sprinklers have achieved acceptance and reported success in communities in the United States. Many of the case studies from the United States indicate that sprinklers are a feasible and attractive fire protection technology. However, our documentation on these communities does not provide detailed statistics and evaluations.

- This technology, if accepted on a universal basis, is argued to have significant long-term benefits for municipalities by reducing operating and capital costs associated with the provision of fire services to the community and to the province in general in reducing medical costs associated with fires.

- Throughout this project we encountered substantial support for residential

25 Although residential sprinklers can provide comprehensive protection, the authors advise that sprinklered homes should also include an interconnected smoke/alarm detector system.

sprinkler systems as a suppression technology. There was a strong recommendation from the focus groups that the issue of residential sprinklers should be reviewed in depth[26] and that some consideration be given to future legislation.

4.2 DESCRIPTION OF SPRINKLERS

A residential sprinkler is a system for in-home fire control. Sprinkler heads are situated in all areas of the home; and are activated by a fusible link which melts when they are exposed to the level of heat experienced in a fire situation. The sprinkler system is controlled by a separate metering system, bypassing the regular water supply to the home. The system requires a constant supply of water to be able to sustain sufficient pressure to fight a fire.

This form of fire protection in the home has developed in popularity in the United States and, as yet, is relatively new to Canada, with only one known installation in Vancouver's North Bay.

In the mid-seventies the only available sprinklers were the type used in commercial properties. They were not appropriate for residential settings. In residential neighbourhoods, due to pipe diameter, the water pressure was usually lower and a sufficient amount of water could not be generated quickly enough to deal with a residential fire using commercial sprinkler standards.

As a result, a new fast-acting sprinkler head was developed which was capable of responding quickly to fires in a residential setting before hazardous conditions were reached. The specifications for the rapid response sprinkler head were

26 Membership in the second focus group was somewhat altered from the first to place more emphasis on private sector attendance. As noted before, the builder/developer sector of the focus group was concerned about increasing home cost; whereas others in the group thought sprinkler legislation an inevitable step towards better home protection. However, both focus groups as a whole agreed that the subject should be investigated further.

incorporated in the United States into a new standard in 1976 - N.F.P.A. 13D Standard for Installation of Sprinklers in One & Two-family Dwellings and Mobile Homes.

4.3 BENEFITS TO HOMEOWNERS

Experience with commercial buildings with sprinkler systems reinforced and encouraged the argument in support of sprinkler systems in one and two-family dwellings and mobile homes. The benefits of sprinklers can be summarized as follows:

- The fact that sprinklers respond immediately to a fire (before a fire truck is capable of reaching it) means early control and suppression of the fire. In fact, the residence, with sprinkler systems, is transformed into its own "fire station" in the event of a fire.

  Sprinkler heads were not specifically designed for smoke suppression. However, the "misting" or "fogging" type of sprinkler may reduce smoke within a compartment. A product manufacturer we consulted was not aware of any tests performed in this area.

- The sprinkler system generally is activated before hazardous conditions (i.e., hazardous levels in terms of temperature, carbon monoxide, oxygen and smoke density) are reached in the residence. Hence, those who are not intimately involved in the fire, but are in the same room as the fire, can be saved.

- If sprinkler heads are activated in corridors and stairwells, it provides safety for occupants trapped in the residence by potentially providing safe escape avenues. Corridors and stairwells are the most common avenues for smoke spread. Alberta Fire Statistics indicate that in 65% of cases

where smoke spread was a factor, corridors and stairwells were congested with smoke. This by-product of fires increases the risk to the occupant.

Note: An NBS report from the U.S. Department of Commerce estimates that fatalities in dwellings could be reduced by as much as 73% with a reliable combined residential smoke detector and sprinkler system.

Homeowners should consider sprinklers if they are not protected by municipal fire departments such as rural housing[27]; or those which are not covered by a municipal fire hydrant system (25% of Alberta residential fires occurred in housing which did not have municipal fire hydrants).

4.4 LIMITATIONS

In summary, full-scale tests revealed the following potential limitations of sprinkler systems: (Source: U.S. Dept. of Commerce)

- Tests revealed that if a fire occurs in a closet (adjacent to a corridor) of less than 24 square feet (NFPA Standards require sprinklers in closets above 24 square feet) dangerous smoke conditions can occur along the escape path.

- If the attic is not insulated, a "wet system" of sprinklers may not be feasible in this part of the home. This will be an unusual condition in Alberta where most attics are insulated.

- Sprinkler systems may not respond as quickly when there is a smouldering fire in a mobile home or in a closed room. It was concluded that sprinklers would provide some, but not complete protection for

27 Creative means to achieve adequate water pressure will have to be considered. Such techniques as a water tank and pump located in basements or attics (or outside the home if properly insulated) are worthy of review.

occupants in the room of fire origin who are exposed to a smouldering fire.

4.5 MYTHS ABOUT SPRINKLERS

There are several misconceptions about residential sprinkler systems that appear to reduce their acceptance by homeowners. Two examples are outlined below:

i) If one sprinkler is activated, they all "go off", thereby causing more damage from water than might be incurred from the fire itself, particularly if the fire is localized.

ii) The sprinkler can be activated by accident causing considerable water damage.

In fact, because of the fusible link in the sprinkler head, only the sprinkler in the room of fire origin is activated. They are not interconnected in terms of their operation. The sprinklers in adjacent rooms would only be activated if the fire reached those rooms.

Studies from the United States[28] indicate that sprinkler systems are reliable. The chances of having an accident, i.e, the sprinkler being activated spontaneously, are remote. A 1980 report prepared by the United States Department of Energy on the performance of sprinkler systems in industrial settings, indicated that the chance of a sprinkler head failing is about one in a million. "The chance of any damage to, or from, a sprinkler system is about one per year for every 800 systems and nearly half the incidents were so slight that the damage to, or from, the system was negligible."

On the basis of actual experience, the damage resulting from the presence of a

28 SFPE Bulletin (Society of Fire Protection Engineers - January, 1984)

sprinkler system is less than one percent of the fire damage that will result if the system is not present. Also, the occupant can turn off the system once the fire is under control.

The only significant possible accident from sprinkler systems is the direct manipulation of the sprinkler head by vandals or children in the household. However, because there are sprinkler heads available today that are unobtrusively designed, they can be installed on ceilings or side walls to be less visible.

4.6 PRODUCT INFORMATION

Appendix A provides a synopsis of some of the major aspects of the residential sprinkler product.

The major components of the system consist of the sprinkler heads and piping. "Headers" or control centres do not vary a great deal between systems.

Residential sprinkler heads differ from commercial heads in the following ways:

- They have a quicker response and a lower operating temperature on their fusible links.
- They have extended coverage with greater performance at lower operating pressures and improved flow rates.

Three types are available:

- Flush mounted: general ceiling installations new &/or retrofit.
- Pendent type: general ceiling installations new &/or retrofit.
- Side wall: generally for renovation installations or special coverage situations, i.e. skylights and odd shaped volumes.

Cost for the three types is relatively similar.

Three types of piping are available: steel, copper and plastic (polybutylene and C.P.V.C.). Steel piping has been the standard material in commercial installations for a number of years, with the introduction of copper more recently. Plastic piping is a relatively new material which has just recently gained acceptance. The following are some advantages and disadvantages associated with the use of each type of piping, as well as general comments.

Steel

- Threaded connections.
- Labour intensive installation requiring a pipe fitter.
- Good material strength.
- Resists expansion and contraction.

Copper

- Soldered connections generally, new equipment on market to speed up installation process, i.e. 'T' joint.
- Commonly used for residential installations.
- Good material strength
- Resists expansion and contraction.
- Does not normally corrode.

Plastic (Polybutylene)

- Heat fusion connection, reported failures in joints.
- Flexible coils.
- Claims of resistance to damage when frozen.
- Does not corrode.

C.P.V.C. (chlorinated polyvinyl chloride)

- Glued connections.
- Rigid pipe.
- Fire resistance rating required in some installation.

The header is the control centre of the residential sprinkler system and consists of five parts:

- Check valve (back flow preventer[29]) prevents water within the sprinkler piping system from re-entering the domestic water supply.
- Drain valve - to drain system or end of line runs.
- Shut-off valve - to turn off water supply.
- Pressure gauge - to indicate pressure of water available.
- Flow switch - electric, centrally activated when water begins flowing through any part of the sprinkler system and may be connected to a bell or an alarm or directly to local fire department.

Three manufacturers' models are available in Alberta: Grinnel, Omega/Reliable and Central Automatic, all of which are manufactured in the United States.

4.7 COST OF RESIDENTIAL SPRINKLERS

Two examples of sprinkler costs are examined in Appendix "A" based on new homes of 1,200 and 2,000 square feet. The figures quoted are based on 1986 Canadian dollars.

29 Representatives from the sprinkler industry indicating that not all municipalities in Canada require back flow preventers. However, the representative of Edmonton Water and Sanitation indicated it probably would be required in Edmonton. As the technology of residential sprinklers is new in Canada and legislation is not yet written, the consultants consider that the issue of the back flow preventer needs further technical and legislative review for Alberta.

For the larger home of 2,000 square feet, new home construction would range between $3,500.00 and $4,500.00. For the smaller home of 1,200 sq. ft., the cost would range between $2,250.00 to $3,200.00. The upcharge for a retrofit installation would be approximately 20% in both situations.

4.8 INSTALLATION

The following summarizes some of the points that an individual home owner must consider before installing a sprinkler system:

- Special precaution is required to ensure that the sprinkler is not installed in an area of the home which is subject to freezing (e.g. an uninsulated attic).

- Wet systems, where water is held in the sprinkler system, offer slightly quicker response time and are more rapid acting than dry systems.

- Dry systems may have some advantages for cold climates, however, technical information on complete residential dry systems was not readily available.

- According to the information gained in the focus groups,[30] a larger water supply service and meter would have to be installed to provide sufficient water pressure to operate the system effectively in most Alberta communities.

30 Again there was divergence of opinion in the focus groups on the need for a separate meter or whether the water to the sprinkler system should in fact be metered at all. The views ranged from those expressing concerns regarding the excessive use of water from an unmetered system to those indicating that there are communities where water is, in any event, not metered and the use of water in this context is not a concern.

- In Edmonton, and possibly other communities, sprinkler systems may require a backflow preventer to prevent water contamination[31]. However, there is some concern on the part of Edmonton Water and Sanitation. They state that water retained by sprinkler systems would eventually lose chlorine effectiveness and could potentially become contaminated. It was indicated that backflow preventers are not 100% mechanically effective and there is the chance of contaminated water leaking into the main water supply.

4.9 ALTERNATIVE SPRINKLERING TECHNIQUES

The focus group and the consultants reviewed a number of alternatives for installing residential sprinklers. These alternatives are offered as ideas. An interested reader would pursue further information on the development of these ideas into possible workable solutions:

- In rural areas where the water supply is from wells and/or water pressure is low, discussion was held on the possible installation of either basement or free standing tanks with pumps or attic cisterns which could supply the sprinkler system.

- Rather than a total sprinkler system, consider providing a sprinkler system only to areas in the home which have the highest occurrence of fires (kitchens, bedrooms, basements). This was considered a potentially dangerous compromise as home owners might feel more protected than they really were.

- Taking the sprinkler lines directly off the domestic water supply system

31 The second focus group discussed the consideration of backflow preventers with the sprinkler manufacturer indicating that they did not believe that backflow preventers were necessary.

might result in less than adequate pressure at the head.

- Using the hot water tank as a potential reservoir of water for the sprinkler system, by adding a pump and sprinkler. This seemed a less adequate system than the sprinkler system recommended in this report.

4.10 PLACEMENT OF SPRINKLERS

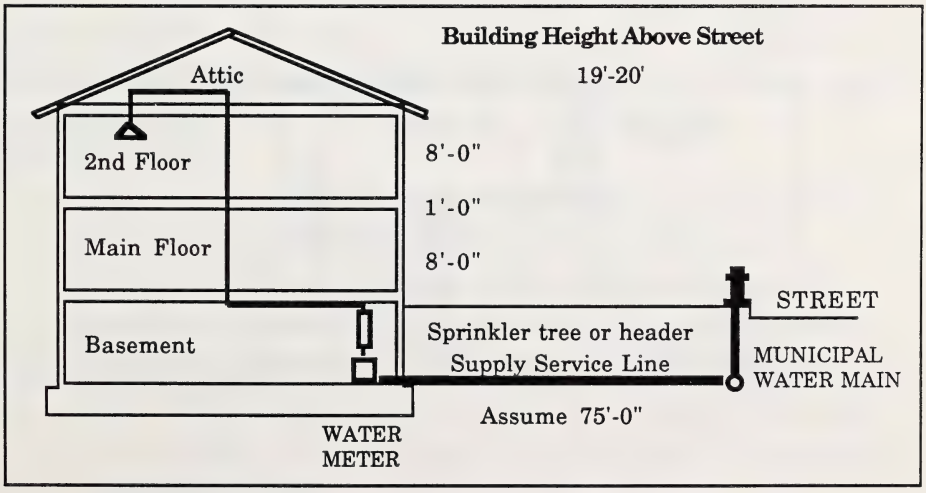
Recommendations for placement of a two storey application is described in the following diagrams.

...IN A TYPICAL 2 STOREY HOUSE

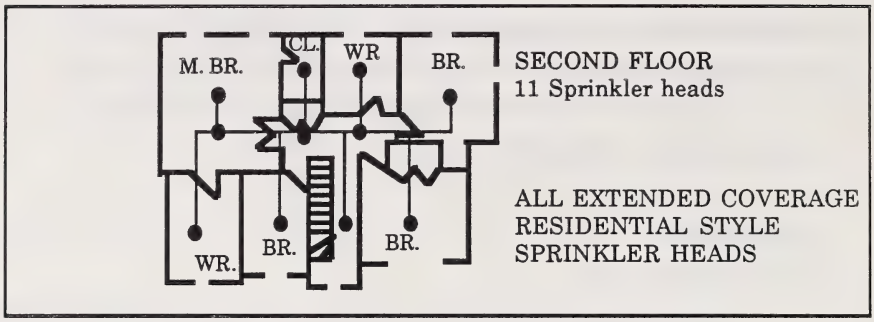
General notes:

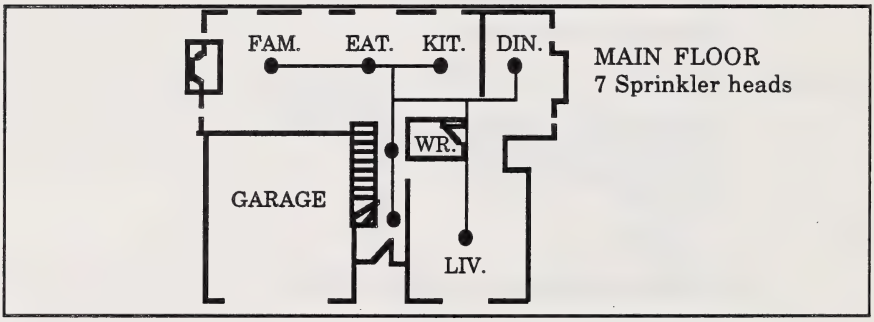
(As per N.F.P.A. 13D)

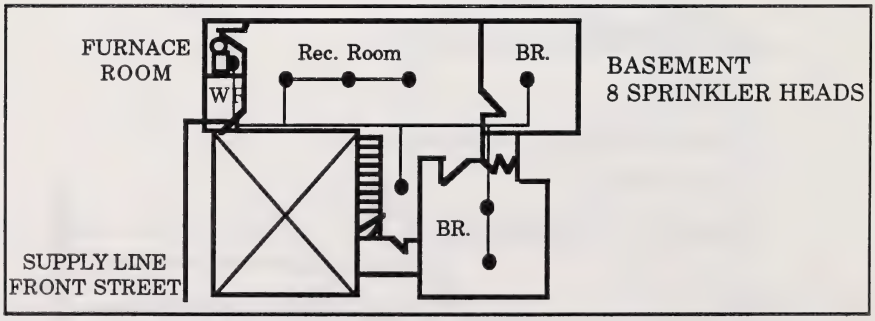
- Maximum area for sprinkler head 144 sq. ft. except if tests show sprinkler head coverage is better, i.e., Grinnel head #991 @ 14' by 14' or 16' by 16'
- Heads - maximum spacing 12'-0" o.c.
- Maximum 6'-0" to wall
- Maximum 8'-0" o.c. within compartment
- Sprinkler all rooms except the following:
  .1 Bathrooms under 55 Sq. Ft.
  .2 Closets under 24 sq. ft.
  .3 Porches
  .4 Garages
  .5 Attics
  .6 Foyers, except used as exit or egress



RESIDENTIAL SPRINKLERS - TYPICAL 2 STOREY HOUSE







4.11 ARGUMENT FOR SPRINKLERED MUNICIPAL DISTRICTS

THE U.S. EXPERIENCE

In various communities throughout the U.S., general ordinances for sprinklering of whole districts have been adopted. Appendix "C" shows the number of U.S. communities that have developed ordinances for entirely sprinklered districts and the escalating number of new municipalities that have taken steps in this direction. These communities recognize the overall economic savings to the community.

There is clear indication, and experts in the focus groups agreed, that American communities that have embarked on these ordinances believed that there would be significant cost savings to the community by the introduction of residential sprinklers:

a) Reduced property losses,

b) Reduced medical costs associated with the treatment of burn victims,

c) Reducing the requirement for construction and maintenance of extensive fire stations and initial engineering infrastructure costs.

Mixed communities in the U.S. (i.e., combining residential, commercial and industrial uses) where sprinkler systems were installed in whole districts reported the following success:

- Fresno, California created a district involving 6 million square feet of mixed residential/commercial space. Most of the buildings were constructed prior to 1926 and had to be upgraded. Fifteen (15) years of experience in Fresno demonstrated the success of such a district. Fire losses were reduced by 94% and there was not a single fire death in those 15 years. Although the population of Fresno grew significantly in this time period the size of its Fire Department was not increased. This suggests an unprecedented success.

- Cobb County had introduced its sprinkler ordinance for whole districts around 1978. At that time, the County's fire losses hit an all time high of $21.49 per capita; and in 1983, with its sprinklered districts, this figure was reduced to $9.78 per capita.

- The loss from fire in a commercially sprinklered building is about 1/5 of the loss in an unsprinklered building. In fact, the U.S. statistics report that there has been no incidence of loss of life due to fire in a fully functioning sprinklered building to date.

The cost/benefit argument, however, only has relevancy if entire districts are sprinklered and if all buildings within the district comply to the ordinance. In that way, a municipality can reduce the number of fire stations required per district (since response time to a fire is not as critical if the residence is sprinklered). The municipality does not have to maintain as extensive a fire staff on call, thereby reducing operating costs of fire departments. Furthermore, the medical expenses incurred by those injured in fires, particularly those suffering from burns, can be drastically reduced if fewer people run the risk of being trapped and injured.

POTENTIAL COST SAVINGS IN ALBERTA

In our attempts to determine costs associated with fire protection in Alberta, we could only obtain general information and based our estimates on the following:

- Alberta estimates the per capita cost for all types of structural fires. This is applicable to the current discussion, since we are advocating the consideration of fully sprinklered districts which would include all classifications of property. This was estimated at $49.25 per capita average in Alberta for 1985 ($11.61 of this per capita cost was related to residential single family, duplex and mobile homes alone).

- Estimates of fire protection costs in the maintenance of fire departments

and staff indicate that Edmonton spends approximately $50M to $60M per year on maintaining fire departments for staff and operating costs. This is converted into a per capita cost of approximately $100.00.

Considering these two categories alone, the per capita cost in Edmonton for fires in all categories is $150.00 per year.

These costs maybe less outside Edmonton and Calgary due to smaller fire departments and volunteer fire fighters, however, fire losses may be higher. This figure does not include costs associated with medical treatment of fire victims. It was not possible for the authors to obtain cost figures associated with medical treatment for injuries and burns resulting from residential fires in our discussions with the Edmonton Burn Unit. Therefore, estimates of the per capita cost of fires to Albertans does not include this aspect of the cost of fires.

However, a study prepared by Hickling-Johnston in June 1983, on a Fire Prevention Model for Northern Alberta, estimated that the dollar value of capital equipment and facilities per person for southern Alberta was $116.00 and for northern Alberta was $102.00 (based on standard costs). Added to this would be the depreciation and long-term maintenance of the building and equipment. Therefore, a very conservative estimate of the cost of fires would be $150.00 per capita, excluding the capital costs of providing fire stations.

In Cobb County, they found that property losses from fires were reduced by more than half (55% approximately). There are no comparable figures available from the U.S. on the reduction of fire department costs and maintenance. However, if we assume that the total costs for fire protection can be reduced by half (which would appear to be a conservative estimate with fully sprinklered districts), this would represent an enormous saving to municipalities over the long-term.

This cursory examination of costs associated with fires in Alberta suggests that a similar strategy as adopted in many U.S. communities could have positive impact in reducing costs for fire protection to Alberta tax-payers.

5.0 SPRINKLER IMPLEMENTATION

In the course of this investigation, it became evident that education and technological solutions for the protection of the homeowner in the event of fire, were inseparable issues. Greater public education is necessary to generate more interest in and use of fire prevention technologies, i.e., installation of smoke alarms/detectors, etc. Greater education of the consumer on home fire protection can be accomplished through greater emphasis in school and through the routine advertising undertaken by product manufacturers.

It is important to review the experience in many U.S. communities in the development and implementation of residential sprinkler ordinances and its applicability to Alberta. There are several points about the U.S. experience that may help municipalities in Alberta to set up strategies to encourage developers, builders and homeowners to adopt fire protection solutions, particularly residential sprinklers.

Several strategies were undertaken by U.S. communities in the U.S. which could be considered by Alberta municipalities. These are summarized below:

Communities obtained the support of key people.

They found that the support of residential developers was necessary. Developers/ builders would be required to install the sprinkler and bear the initial burden of cost and would then sell consumers on the benefits of sprinklered homes and the associated cost. As a result, municipalities offered incentives, specifically, reduction of development costs through reduced taxes, infrastructure costs or removal of development restrictions.

They provided incentives to developers

In Wrightsville Beach, North Carolina,, the local water works department cooperated by offering developers free water connections in sprinklered buildings. In unsprinklered buildings, the water tap fees range from $1,500 to $2,500 per residence. Hence, it was a significant incentive which made sprinklering more attractive for developers.

In other areas building ordinances were modified to allow greater construction and access trade-offs to developers who sprinklered their buildings. For example, in walk-up residential apartments, the following construction trade-off allowances were allowed:

Without Residential Fire Protection Protection: No Sprinklers		With Residential Fire Protection: Sprinklers
• Units must be within 5 minute response of nearest fire station.	➳	Waived
• Units must not be located more that 150 feet from closest vehicular access way	➳	Waived
• Standard street widths required	➳	Reductions permitted
• Street Grade of 15% or greater not permitted	➳	Waived
• Must adhere to hydrant spacing requirements	➳	Greater hydrant spacing permitted
• Fire (hydrant) flow requirements must be met	➳	50% reduction in required fire (hydrant) flow

Studies in the U.S. demonstrate significant trade-offs in construction for higher density residential developments. However, these will not necessarily imply the same reduction construction ordinances for individual single family dwellings.

They ensured that designated individuals in local fire departments were sufficiently knowledgeable about the system, so that they could provide assistance and guidance to local builders and developers.

They found in the U.S. that initially developers and builders had little knowledge of the systems and needed the assistance of "experts" such as the fire department.

In addition, this enabled the Fire Department to convey its endorsement of sprinklers to the community.

They generated regular press releases to the public on the advantages of sprinkler systems, reinforcing the life-saving benefits.

The American situation demonstrated that arguments which point out the life-saving attributes were more compelling than those which emphasized the property loss in fires. The horror of being caught in a fire is more compelling in selling fire protection technologies than the risk of property loss.

They provided incentives to consumers.

U.S. incentives had been provided through reduced insurance rates, and in one situation (Alaska), residents were offered a 2% reduction on their property tax assessments, if they had sprinkler systems.

In some areas of the U.S., where residential sprinkler ordinances exist, insurance costs have been significantly lower to the consumer. In some cases, insurance rates were reduced up to 13% off the base premium for total household insurance on residential properties with sprinkler systems; and up to 15% if the system is combined with fire alarms. If the fire alarm system is also tied to the fire department, further reductions up to 30% are possible. Given that the fire portion of the average householder is approximately 40%, these reductions represent a significant saving. Since residential sprinklers are not as extensively used as in parts of the U.S., there is no concrete information available on what Canadian residential insurance rates would be if a home were installed with sprinklers.

In new construction, it may be relatively easier to promote sprinkler systems and installation of smoke alarms than it would be in retrofit situations. In the first situation, consumers buy into the system, as when purchasing a home, and therefore may not "feel" the costs which are built into the development. Hence, he/she does not have to pay separately for the system, as the cost is not translated to the consumer in that form.

However, in a retrofit situation, direct incentives to the consumers will likely be necessary to ensure acceptance. These may include tax incentives and rebates on purchases of materials (similar to the Canadian insulation program, etc.). Furthermore, it will be necessary to initiate a mass media promotion campaign on the benefits of sprinkler systems, which might be co-sponsored by the major sprinkler manufacturing companies.

PROMOTION

The move toward sprinkler ordinances was promoted at the federal level in the U.S.; and there was considerable endorsement and enthusiasm engendered for the program at the grassroots level. It is suggested that the provincial government might consider endorsing the general policy of residential sprinklers, in order to generate the proper momentum and to establish guidelines and proper standards for implementation.

6.0 CONCLUSIONS

This section describes the major conclusions and recommendations arising from this study.

6.1 FURTHER STUDY ON RESIDENTIAL SPRINKLERS

Much of the documentation on U.S. case studies did not provide the full economic argument, nor describe in detail the conditions that existed in the community at the time of the adoption of the ordinances. Therefore, detailed comparisons with Alberta were not possible.

There appear to be a number of issues which make the climate of acceptance easier in the United States than in Canada. While it is difficult to be confident about the reasons for these differences, there are five issues to consider:

Climate - Generally, implementation of residential sprinkler systems started in the warmer states where cold and frost make less of an impact on infrastructure costs.

Political - There appears to be more individual community ability to instigate residential sprinkler ordinances. Further, although there are many state codes, few of these codes override local autonomy and municipal jurisdiction.

Cost savings - There was strong commitment at both the municipal and the national level to cut back on the overall cost of fire fighting.

Water pressure - Some evidence exists to indicate that U.S. communities which initiated residential sprinkler systems ordinances had higher water pressure than would be commonly found in many parts of Alberta.

Type of community - It appears that fast growing and/or isolated communities without fire departments accepted residential sprinkler systems more rapidly.

It is strongly recommended that further work be undertaken towards the development of a cost-benefit assessment and articulation of the preconditions necessary to establish a sprinklered district in Alberta, through examination of U.S. communities which have adopted sprinkler ordinances and those which, faced with the decision, decided against the option of having sprinklered districts. This type of examination can be carried out by visiting the communities and interviewing key individuals involved.

It should be noted also that the California State Fire Marshall has announced the formation of a Residential Sprinkler Systems Advisory Committee to examine current residential sprinkler standards and to establish uniform standards for residential sprinklers. Activities of this committee should also be reviewed.

Therefore, we recommend the following areas of further investigation:

- Visits to U.S. communities which have adopted sprinkler ordinances and those which have rejected this technology to conduct a detailed comparative analysis.

  Furthermore, the communities with sprinkler ordinances that are selected should have had the sprinklers installed in residences, if possible, for a protracted period of years to allow sufficient long-term analysis of the benefits and costs.

- Selection of communities for the investigation on the basis of similarity of geography and environment to Alberta, to make the analysis as comparable as possible.

- Interviews with individuals in these communities who represent a diverse

range of perspectives on the issue of sprinkler systems, i.e., municipal planning representatives, developers, residents' associations, fire department representatives, etc.

In addition,

- NFPA statistics on residential sprinklers should be examined in greater detail and interviews with representatives from this organization would be advisable.

- The North Bay proposed development for a totally sprinklered district in British Columbia should be examined.

6.2 ENCOURAGING RESIDENTIAL SPRINKLERS IN ALBERTA

We suggest that an Alberta municipality should be encouraged to engage a developer in an experimentation program to include sprinkler systems in residential developments, similar to the program being considered for the North Bay development in Vancouver. (A description of the background of this program is offered in the Appendix.)

6.3 RESIDENTIAL SMOKE DETECTORS AND ALARMS

In this report, we recommend the legislation of comprehensive, interconnected, all-level smoke alarms/detectors in all dwellings.

In an average home we estimate that the cost should not exceed $300.00 (including labour) for 6 units for a new residence and somewhat higher for an existing dwelling.

The main target market for installation of this system in new housing is the

developer. Negotiations and provision of incentives to implement these requirements should be directed to the developer rather than to the consumer. As the cost of installation is minimal, it can be easily worked into the sale price of the home.

The other area of consideration is to make the code sufficiently comprehensive in order to provide specific direction to the developer to ensure that an appropriate smoke alarm/detector system is installed in new homes; if this is done then Part 9 of the Alberta Building Code would require some modification. N.F.P.A. 74 Standards for the Installation Maintenance and Use of Household Fire Warning Equipment could be used as useful information in drafting the changes in legislation.

The second recommendation -- that the code be retroactive to existing housing -- will be significantly more difficult to implement. This puts a direct and identifiable financial burden onto the consumer and will likely receive considerable resistance. Furthermore, it will be legislation that will be unpopular and difficult to enforce.

Prior to implementation of a strategy to encourage retroactive installation of smoke alarms/detectors further research into the legislative opportunities available and potential consumer reaction is advised.

Many of the participants in our focus group argued that it may not be "ethical or moral" (sic) to impose such legislation on the existing housing stock and recommended that this requirement could be better satisfied through a public education program or through direct incentives to the consumer.

We recommend that consideration be given to some retroactive components (amendments to the legislation). For instance, municipalities might be directed to require all applications for residential building permits (both new construction and renovation) to include smoke alarms/detectors as specified in this report. Further, governmental and/or insurance incentives might be considered.

We recommend that consumer awareness of smoke alarms/detectors should be researched, specifically their perceptions of benefits and limitations and their general knowledge of the maintenance and operation of smoke alarms/detectors. This would assist in the development of a media campaign to educate consumers about smoke alarms/detectors.

6.4 SUMMARY

This study reviewed several technologies that could be used in homes to reduce fire risk or to curtail some of the damage and injury incurred when a fire occurs. There is increased safety afforded by certain measures. For instance, as a minimum protection measure, we recommend that all homes should be equipped with interconnected fire alarms/detectors and fire extinguishers (as discussed throughout this report).

There are a variety of other technologies that could be added to these, to provide a more comprehensive system of fire protection in the home.

One of the major conclusions arising from this study is that careful consideration should be given by individuals and government policy-makers to the development of long-term legislation and regulations for installation of residential sprinklers in whole districts for new developments. However, more work is required to determine the impact of this technology. We suggest that government look more carefully to examples in the U.S. where sprinkler ordinances have been implemented to determine the impact of the regulations, both socially and fiscally.

APPENDICES

A. DETAILED DISCUSSION OF RESIDENTIAL SPRINKLERS
   - i) General
   - ii) Sample Calculations
   - iii) Costs

B. CANADIAN EXPERIENCE WITH ENTIRE SPRINKLERED DISTRICTS: VANCOUVER, NORTH BAY, BRITISH COLUMBIA.

C. U.S. COMMUNITIES WITH SPRINKLER ORDINANCES

D. HOW TO USE FIRE EXTINGUISHERS

APPENDIX "A"

DETAILED DISCUSSION OF RESIDENTIAL SPRINKLERS

i) GENERAL

We have outlined a prototypical residential sprinkler system design and estimated costs associated with each aspect of the system to achieve performance levels specified by the N.F.P.A. 13D Standard for Installation of Residential Sprinkler Systems. The example represents a "typical" new construction dwelling. Every eventuality that might arise when installing a sprikler system in a new dwelling could not be anticipated; therefore, this example is not intended to represent every possible situation. However, we have attempted to provide an above "average" home to ensure that all major components of the system could be included.

In our examples we have used the City of Edmonton as the main location because of the diversity of water pressure experienced throughout the City. Our assumption was that Edmonton represents one of the more difficult geographical locations for sprinklers in Alberta. Therefore, if it can work in Edmonton, it can be adapted elsewhere in Alberta.

Considerations:

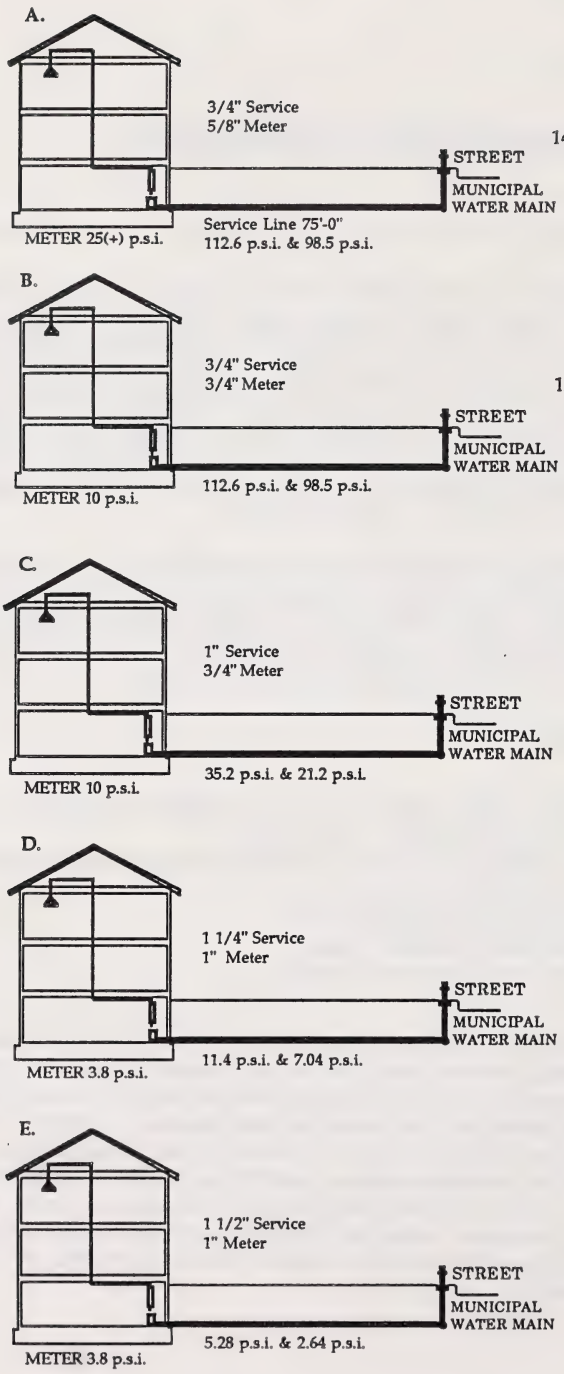
- N.F.P.A. 13D design criteria for residential sprinklers.
- Two storey dwelling c/w basement.
- 75'0" distance of dwelling to street water main (after discussion with City of Edmonton).
- Assumed design safety factors.
- Residential sprinkler heads.
- Copper piping (accepted norm).

While designing the residential sprinkler system, it became apparent that the water supply service was a key factor in its effectiveness. Interior dwelling layouts and piping arrangements do not have as significant an impact on the operatio of the system as does the supply system. The example represents a prototypical two storey dwelling with sprinkler heads laid out according to the recommendations established by N.F.P.A. 13D. To illustrate the impact different water supply services could have, we have calculated a number of scenarios given different servicing options to demonstrate the p.s.i. required to achieve optimal performance of the sprinkler heads.

SUMMARY

PRESSURE REQUIRED AT THE STREET TO OPERATE SPRINKLERS HEADS (p.s.i.)

	1 HEAD	2 HEADS
A. 3/4" Service 5/8" Meter	143.5	157.8
B. 3/4" Service 3/4" Meter	128.5	142.8
C. 1" Service 3/4" Meter	51.1	65.4
D. 1 1/4" Service 1" Meter	30.8	35.5
E. 1 1/2" Service 1" Meter	26.4	29.3



Summary

The following five examples indicate various combinations of Supply Service and Meter Sizes starting with the most common existing condition (3/4" line) in the City of Edmonton. The Supply Service Line from the street to the dwelling has the largest impact on the pressure loss, as can be seen in the more than 50% changes between items B and C.

	Pressures required at the street to operate sprinkler heads (in psi)
A. Existing Standard Conditions Within the City of Edmonton	
Service Size 3/4"	1 Head 143.57 psi
Meter Size 5/8"	2 Heads 157.88 psi
B. Existing Service Size with Upsized Water Meter	
Service Size 3/4"	1 Head 128.57 psi
Meter Size 3/4"	2 Heads 142.88 psi
C. Proposed Upsize in Service and Meter	
Service Size 1"	1 Head 51.13 psi
Meter Size 3/4"	2 Heads 65.44 psi
D. Proposed Upsize in Service and Meter	
Service Size 1 1/4"	1 Head 30.85 psi
Meter Size 1"	2 Heads 35.48 psi
E. Proposed Upsize in Service and Meter	
Service Size 1 1/2"	1 Head 26.45 psi
Meter Size 1"	2 Heads 29.32 psi

Note:

- Other combinations of variables are possible. We feel, however, that the above combinations represent an adequate sample.

- City of Edmonton Standards indicate that the water meter size is usually one size increment down from the size of the incoming water supply line.

- The City of Edmonton (Water and Sanitation Department) require minimum sizes for water service connections based on domestic demands. Interviews reveal that Water and Sanitation are under pressure from Developers to keep these sizes to a minimum as it is the Developers who must pay for the connection costs from the dwelling units to the City water main located in the street or alley.

- Note that within existing water main pressure varies between 30 and 70 p.s.i. at the water main. Water and Sanitation guaranteed a minimum of 30 p.s.i.

ii) SAMPLE CALCULATIONS

Sample calculations of a residential sprinkler system for a typical two storey house (main and second floor area at 2,000 sq. ft. and basement of 900 sq. ft.) using copper piping.

Calculations:

Performed generally conforming to N.F.P.A. 13D "Installation of Sprinkler Systems in One and Two Family Dwellings and Mobile Homes".

General Criteria - N.F.P.A. 13D:

- maximum area 144 sq. ft. except if test results indicate that coverage is better.
- heads - maximum spacing 12'0" o.c.
- maximum 6'0" from wall
- maximum spacing within compartment 8'0"
- sprinkler all rooms except

1) bathrooms under 55 sq. ft. with non combustable fixtures.
2) closets under 24 sq. ft.
3) porches
4) garages
5) attics
6) foyers, not used as a means of egress

Calculations

.1 Calculations:
are based on the sample calculation sheet in NFPA 13D (fig.A-4-4.3(1)). Calculations were completed from the sprinkler heads back through the system to determine the pressure required at the street in lieu of determining the pressure available at the sprinkler head given the public water supply pressure. This was done due to the variable nature of the City of Edmonton water supply pressure (30 to 70 p.s.i.).

.2 Sprinkler Heads:
per N.F.P.A. 13D 4-1.1 (N.F.P.A. requires designs to be based on a situation where 1 or 2 sprinkler heads are activated).

Grinnell - Flush Pendent Model F991 Aquarius K = 4.2
P=pressure
K Factor = coefficient of discharge
Q=quanity of flow in GPM

$KP/P = (QK)^2$

One Sprinkler Head
18 gpm = $P = (18/4.2)^2 = (4.28)^2 = 18.36$ psi operating pressure

Two Sprinkler Heads
13 gpm = $P = (13/4.2)^2 = (3.09)^2 = 9.58$ psi operating pressure.

.3 Distance to Street Main: assume 75'0" (This assumption is based on discussions with The City of Edmonton Water and Sanitation Department which considered this to be a reasonable average distance to use for calculation purposes).

iii) COSTS

The following costs are based on the 2-storey example of a 2,000 sq. ft. house. Costs for a 1,200 sq. ft. residence can be approximated as a proportion of the 2,000 sq. ft. calculation.

Residential Sprinklers-New Developments

Based on the assumption of: maximum upsize in water supply and meter. Costs are calculated on 1986 cost figures.

.1 Supply Line

Up Charge from 3/4" 'K' copper supply to 1 1/2"
(from Yardsticks for Costing)

3/4" @ $7.20/L.F x 75' 0" =	$540.00
1 1/2" @ $12.90/L.F. x 75' 0" =	$967.50
Up Charge	$427.50

Material costs only, trenching and labour should be similar.

.2 Meter Size

5/8" x (1/2") City of Edmonton Standard	$105.00
1" meter	220.00
Up Charge	$115.00

.3 Sprinkler System

Pricing is difficult to estimate due to the limited number of installations and variations in layouts however.

1) Yardsticks for costing indicate $170.00 per head.
Sample case 26 heads @ $170.00 ea = $4,420.00

2) Square Foot Costs
Sample case 2,000 sq. ft. @ $1.50/sq. ft (+) = $3,000.00
(based on general information from Grinnell Vancouver Office)

Therefore, total cost would range from approximately $3,500.00 to $4,500.00 for new developments using the examples given.

Residential Sprinklers - Retrofit

.1 Supply Line

In areas of existing developments, upgrading of service lines is considered not feasible. Therefore these installations would only be possible where existing water pressures are sufficient to operate the system (Fig. 3 indicates that existing 5/8" service lines would require 145 to 160 psi for our examples).

.2 Meter Size

Up Charge same as new construction except for additional labour charges:

Meter Cost	$115.00	
Labour to install	300.00	
	$415.00	(estimate)

.3 Sprinkler System

The sprinkler system costs would be similar to that of a new installation except for an up-charge for working within existing conditions. We estimate this surcharge to be approximately 20% for

totals of $4,200.00 to $5,400.00. The surcharge percentage would vary depending upon the existing dwelling unit (i.e. number of storeys, construction method, layout, wall thickness, etc.).

APPENDIX B

CANADIAN EXPERIENCE WITH ENTIRE SPRINKLERED DISTRICTS: VANCOUVER, NORTH BAY, BRITISH COLUMBIA.

Submitted by: Resolution Committee, ACFM & FC

Subject: INSTALLATION OF AUTOMATIC SPRINKLERS IN ONE AND TWO FAMILY DWELLINGS

WHEREAS more than 70 percent of fire deaths in North America occur in one or two family dwellings, and

WHEREAS there is evidence that automatic sprinkler systems, especially fast response sprinkler systems, are effective in preventing loss of life, reducing injuries and property loss from fire,

THEREFORE BE IT RESOLVED that the Association of Canadian Fire Marshals and Fire Commissioners advocates the principles of automatic sprinkler protection in one and two family dwellings,

BE IT FURTHER RESOLVED that the ACFM & FC request the National Research Council amend the National Building Code of Canada to require installation of fast response residential sprinkler systems in one and two family residential buildings as regulated by Part 9 of the National Building Code.

CITY OF VANCOUVER

MEMORANDUM

From: CITY CLERK

Date: 29 May 1986

To: CITY MANAGER
DIRECTOR OF PERMITS & LICENSES
FIRE CHIEF
DIRECTOR OF PLANNING
DIRECTOR OF FINANCE
COMPTROLLER OF ACCOUNTING
COMPTROLLER OF BUDGETS & RESEARCH

Refer File: 8010-5

DEPT. PERMITS & LICENCES
RECEIVED
MAY 30 1986
Reg. No. 7570.2

Subject: Fully-Sprinklered District Within North Park (Joint Study)

I wish to advise you of the following extract from the minutes of the Vancouver City Council meeting of Tuesday, May 27, 1986, when dealing with the attached report of the City Manager, dated May 23, 1986, with regard to the above matter:

"In considering this clause, the officials were asked to examine whether such a proposal could be applied to other existing areas.

MOVED by Ald. Bellamy,
THAT the recommendation of the City Manager, as contained in clause 1 of this report, be approved.

- CARRIED UNANIMOUSLY"

CITY CLERK

MCross/lc
Att.

Also sent to:

B.C. Place
P.O. Box 11626, 21st Floor
650 West Georgia Street
Vancouver V6B 4N9

A-6

FIRE AND TRAFFIC MATTERS

RECOMMENDATION

1. Fully-Sprinklered District Within North Park (Joint Study)

The Director of Permits & Licenses reports as follows:

"PURPOSE

The purpose of this report is to seek Council's approval for a joint study with B. C. Place of the possibilities and consequences of making "North Park" a district in which every single building is equipped with sprinklers.

BACKGROUND

Sprinklers in individual buildings have long proven themselves effective in extinguishing and controlling fires. They reduce the loss of life and property, give the Fire Department more "rescue time", and substantially lessen the number of hoses needed to fight a fire, if needed at all.

Hence, sprinklers now are a requirement in many buildings codes in North America for new buildings, particularly buildings over three stories in height.

The advantages of sprinklers in individual buildings are magnified if it were possible to ensure that every building in a whole district has sprinklers.

- It will allow the district to be designed with smaller water-lines feeding the hydrants.
- It could result in relaxations in the design and location of buildings, and in the use of certain building materials.
- It should have an appreciable effect on the demand for firefighting services.

There are problems in creating such districts retroactively

- Most small houses now have 3/4" water connections which would need to be enlarged to 1".
- Installing sprinklers in existing buildings is often costly and disruptive, while compensating savings to the owner are not so obvious.

Nonetheless, there have been experiments in creating fully-sprinklered districts retroactively. Fresno, California created such a district involving 6M square feet of commercial space. Most of the buildings were built prior to 1926, and had to be upgraded retroactively.

15-years' experience in Fresno fully proved the success of such a district. Fire losses were reduced by 94%, and there was not a single fire-death in those 15 years. The population of Fresno increased significantly without increases to its Fire Department.

/2...

Clause No. 1 continued

This success was achieved even with existing slow acting sprinkler heads. New and much faster-acting heads are now available and should produce even more dramatic results.

VANCOUVER SITUATION

Until the early 1970's Vancouver experienced many multiple fire deaths in downtown lodging houses. Council decided on a program of upgrading these buildings, including retrofit sprinklers. The results were a great reduction in loss of life and property.

Gradually, all highrise office towers were added to the list, and recently highrise assembly and school buildings, were also added.

Most fire deaths now occur in smaller residential buildings, where sprinklers are not now mandatory. The City has no experience with a district where every building must have sprinklers, but the development of North Park provides such an opportunity.

WHAT CAN BE DONE IN NORTH PARK

The new district of "North Park" on B. C. Place lands is scheduled for redevelopment, starting in 1987. It will have a mixture of building sizes and uses, but most will be residential.

The architects of North Park have approached the City about the possibility of making North Park a fully-sprinklered district, with compensating trade-offs in the design of buildings and use of materials.

We believe a joint study is warranted to find all the costs and savings associated with a fully-sprinklered district, and to determine the trade-offs that could be granted to the developers in such a district (see Terms of Reference in Appendix A).

The study would be carried out by a task-force of appropriate City staff, B. C. Place staff, and some fire protection consultants. The cost of the study, (excluding staff-time) would be between $10,000 and $20,000. We propose it be shared jointly with B. C. Place.

The results of such a study would have application in other parts of the City and elsewhere. Hence, some outside funding may be available.

RECOMMENDATION

The Director of Permits and Licenses, with the concurrence of the Fire Chief, recommends:

A. Council approve the carrying out of a joint study with B. C. Place, to determine the full implications of sprinkler costs and appropriate trade-offs for the North Park district.

B. Council request the City Manager to seek some research funding from the Province, UBCM, or the Federal government to help finance the above study.

C. Council approve the funding of $10,000 for up to 50% of the costs of the study, pending the outcome of (B), with the source of funds to be Contingency Reserve.

D. Council approve the formation of a task group of appropriate Civic Departments and B. C. Place staff, together with fire protection consultants, to work as a team in reviewing the implications and trade-offs being considered in the report."

The City Manager RECOMMENDS approval of A, B, C, and D.

APPENDIX A

STUDY OF FULLY-SPRINKLERED DISTRICTS

TERMS OF REFERENCE

1. Water Supply Requirements

   a) Within buildings.
   b) To fight exterior fires.
   c) Type of fire hydrants required.

2. Fire-fighting Access Requirements

   a) Size of responding vehicles.
   b) Type of equipment necessary.
   c) Width of access roads.
   d) Design response time for fire fighters.
   e) Central response locations.

3. Fire-fighting Standpipes

   a) Requirements for Class II connections?
   b) Requirements for fire hose cabinets?
   c) Other relaxations possible?

4. Building Construction Requirements

   a) Should there be maximum building areas?
   b) Type of construction related to building heights.
   c) Requirements for spatial separation?
   d) Review of building fire resistance requirements.
   e) Fire resistance of suite separations.
   f) Fire resistance of occupancy separations.
   g) Requirements for shaft design.
   h) Requirements for fire dampers.
   i) Fire-ratings for closures in fire separations.
   j) Relaxations for interior finishes (FSR and SDC).
   k) Handling openings between storeys.
   l) Relaxation of rated roof construction.
   m) Requirements for roofing classification.
   n) Requirements for exterior cladding materials.

5. Building Egress Requirements

a) Any changes allowable to modes of egress?
b) Can we relax the number of exits in some cases?
c) Any relaxations to widths of exits?
d) Can we lengthen travel distances?
e) Can we shorten remoteness of egress?
f) Lower fire-rating of fire protection of exits?
g) Any changes possible for public corridor requirements?
h) Any changes possible for access to exit to public corridors?
i) Any increase to number of lobby exits?
j) Any changes to horizontal exits?
k) Can we increase FSR for finishes within egress routes?

6. Highrise Requirements

a) Modification possible to areas of refuge for handicapped?
b) Relaxation for cross-over floors.
c) Other relaxations possible?

7. Service Rooms and Spaces

a) Possible reduction to fire resistance rating?
b) Permit washrooms in exits?
c) Other relaxations?

8. Fire Detection and Alarms

a) Relaxation to pull stations in residential buildings.
b) Relaxation to annunciation.
c) Other relaxations?

9. Extra Costs and Savings Associated with Trade-offs

10. Cost-Benefit Analysis

a) Savings to the property owner (building construction, more useable space, etc.)
b) Savings to the City (water supply, hydrants, fire vehicles, etc.)
c) Savings to the occupants (insurance premiums, etc.)

RLM:lc
March 27, 1986.

APPENDIX C:

UNITED STATES COMMUNITIES WITH SPRINKLER ORDINANCES

RESIDENTIAL SPRINKLER PROGRAM UPDATE

- CONTENTS -

SECTION I - CONTACT PERSONS
SECTION II - ACTIVE PROGRAMS
SECTION III - PROGRAMS UNDER CONSIDERATION

Preface

This document contains information about community programs that promote or require the use of residential sprinkler systems.

Section I contains the name and phone number of a contact person in all communities which have a program. These communities either have a program or are in the process of creating a program. For the mailing address of any communities, contact the community directly or contact OLS for a list of all addresses.

Section II contains only the names of those communities that have established a community program. This list also contains information on the type of program and the classes of residential occupancies that fall under the current program in each community.

Section III contains the names of those communities that are in the process of implementing a program to promote or require the use of automatic sprinkler systems in residential occupancies. Again, the list has the information about the type of program and the classes of occupancies to be covered under the new program.

All of the lists are arranged alphabetically by state. Those states that are on the list in all capitals indicate that a program is in effect or under consideration on the state level.

Sections II and III only contain those communities that returned OLS's Residential Sprinkler Activity Questionnaire. The information in these lists was provided by the contact person (generally the Fire Chief or Fire Marshal) of the community and OLS has not yet verified its accuracy. For further information concerning a program in any of these communities you may contact them directly as listed in Section I, or you may call or write:

Operation Life Safety
1329 18th St., N.W.
Washington, D.C. 20036
(202) 833-3420

SECTION I - CONTACT PERSONS

Updated January 16, 1987

State	Community	First Name	Last Name	Phone
ALASKA		Sylvester	Neal	907-269-5491
	Anchorage	Ross	Fosberg	907-267-4960
	Ketchikan	M.G.	Fisher	907-225-9616
	North Slope Borough	Tom	Opie	907-852-3473
ARIZONA		Paul	Saunders	602-231-6313
	Chandler	Bart	Beckworth	602-899-9712
	Lake Havasu	Robert	Weber	602-855-1141
	Peoria	Mike	Fusco	602-979-3720
	Scottsdale	Bob	Edwards	602-994-3886
	Tucson	Richard	Moreno	602-791-4511
CALIFORNIA		James	McMullen	916-427-4155
	Anaheim	Darrel	Hartshorn	714-999-1800
	Arroyo Grande	Douglas	Hamp	805-489-1303
	Barstow	David	Mathews	619-256-2254
	Belmont	Gary	Schmitz	415-593-8011
	Beverly Hills	Bill	Daley	213-550-4902
	Bridgeport	Lou	Best	619-932-7471
	Campbell	Gary	Smith	408-866-2194
	Carmel Highlands	Lanny	White	408-624-2374
	Carpinteria	Claude	Welch	805-684-4591
	Clovis	Dennis	Byrns	209-297-2460
	Columbia	Jim	O'Hearn	209-532-5672
	Corte Madera	Larry	LaFresnaye	415-924-2901
	Davis	Don	Sylvia	916-756-3743
	El Monte	Charles	Masten	818-575-2200
	Encinitas	Robert	LaMarsh	619-753-1193
	Escondido	Bob	Watts	619-741-4696
	Fontana	James	Lawrence	714-823-2681
	Fort Bragg	Robert	Ramage	707-964-4026
	Foster City	John	Bettencourt	415-574-5246
	Fresno	Carl	Armstrong	209-488-1542
	Fullerton	Ron	Coleman	714-738-6500
	Glendale	John	Montenero	818-956-4814
	Hanford	George	Watson	209-584-6323
	Hawthorne	Ralph	Hardin	213-970-7968
	Healdsburg	Ken	Hanley	707-433-2182
	Huntington Beach	Raymond	Picard	714-536-5401
	Imperial	Lon	Hettinger	619-355-1158
	Kern County	Carl	Williams	805-861-2577
	La Mesa	James	Orsborn	619-461-6101
	La Quinta	Ray	Hebrard	714-657-3183
	Livermore	Michael	Sample	415-477-2232

APPENDIX "D"

HOW TO USE FIRE EXTINGUISHERS

Fire extinguishers are filled with either water, dry chemical or Halon. The dry chemical extinguishers are filled with mono-ammonium phosphate, ammonium phosphate, potassium or sodium bicarbonate.

The "Canadian Consumer" (August, 1985 issue) recommends that a multi-purpose (ABC Class) fire extinguisher be installed for each storey of one's home. Extinguishers cannot be located close to extreme heat as the heat can cause, in extreme circumstances, an explosion of the pressurized containers. Extreme cold should also be avoided.

Canadian Consumer recommends in the case of fire:

- First get everyone out of the house.
- Call the fire department, whether the fire is large or small.
- Fight small fires only. If a fire gets out of control, get out, closing doors behind you to slow the fire's spread.
- Make sure you don't use the wrong class of extinguisher for the fire - it may make it worse. A common error is using water on a liquid or electrical fire. If an appliance is smoking or burning, pull the plug.
- When using an extinguisher stay close to an exit in case the fire gets out of control.
- Follow the manufacturer's instructions for minimum and maximum distances when using an extinguisher.
- Don't be stingy with the contents. It's best to discharge the extinguisher completely if you're not sure that the fire is out.
- Keep low and avoid breathing the smoke as much as possible. Fumes from burning synthetics used in some carpets and upholstery can be toxic.
- Make sure you get the "all-clear" from the fire authorities before you and your family re-enter the house.

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